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Item Response Theory Analysis of Binge Drinking and its Relationship to Lifetime Alcohol Use Disorder Symptom Severity in an American Indian Community Sample

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Abstract

Background—Item Response Theory (IRT) has been used to examine alcohol use disorder (AUD) symptoms and their psychometric properties but has not been previously applied to AUD symptoms from an American Indian sample.

Methods—Lifetime DSM-IV AUD symptoms and binge drinking (5+ drinks men/4+ drinks women) at ≥ 1 , ≥ 4 , ≥ 8 , ≥ 15 days per month during the period of heaviest lifetime drinking criteria were assessed in 530 American Indian participants. Exploratory (EFA) factor analysis was used to examine the factor structure of the ten AUD symptoms and each alcohol consumption criterion. Two-parameter IRT models generated marginal maximum likelihood estimates for discrimination (a) and threshold (b) parameters for ten DSM-IV AUD symptoms and each consumption criterion. Differential Item Functioning (DIF) analysis was used to assess AUD symptom severity in groups defined by gender and age at interview.

Results—The AUD symptoms of “Withdrawal” and “Activities Given Up” were the most severe symptoms. “Tolerance” and “Social/Interpersonal Problems” were the least severe. All AUD symptoms fell on the moderate portion of the severity continuum, except “Withdrawal”, which fell at the lower end of the severe portion. The consumption criterion of 5+/4+ (male/female) at ≥ 8 times per month demarcated the portion of the severity continuum where AUD symptoms began to occur at a probability of 50%. DIF analysis showed significant gender and age at interview differences for “Hazardous Use,” “Tolerance,” and “Activities Given Up,” but not for the other AUD symptoms.

Conclusions—In this American Indian community sample, alcohol abuse and dependence did not represent distinct disorders. Only one AUD symptom was found outside the moderate portion of the underlying AUD severity continuum. Drinking 5+/4+ (male/female) drinks at a frequency of ≥ 8 times per month during the period of heaviest lifetime drinking was found to function well as both a risk and a diagnostic criterion for lifetime DSM-IV AUD. DSM-IV AUD symptom criteria, as currently assessed, may be limited in their ability to capture the full range of symptom severity of AUDs, at least in this high risk population.

Keywords

IRT; Binge Drinking; Alcohol Symptoms; Native American

Introduction

Efforts to delineate factors which contribute to increased likelihood of developing alcohol use disorder (AUD) symptoms over the lifetime in Native Americans are important because of the high burden of morbidity and mortality that AUDs pose to some Native American communities. Although use of alcohol varies among tribes, as a whole Native Americans suffer higher alcohol related death rates than any other U.S. ethnic group and five times that of the general U.S. population (Ehlers et al., 2006; May, 1982; May and Smith, 1988; Shalala et al., 1999). Rates of alcohol dependence in the small number of tribes studied have been reported as 20% - 70% (Beals et al., 2005; Ehlers et al., 2004; Kunitz, 2006; Robin et al., 1998).

Beginning with early ethnographic studies, differences in the patterns of Native American drinking that might give clues to its nature and etiology have been sought (Heath, 1975; Leland, 1980; May, 1977). One drinking pattern that has been extensively commented on is binge drinking (Ferguson, 1968; French and Hornbuckle, 1980; Kunitz and Levy, 1994; Levy and Kunitz, 1974; May, 1982; Quintero, 2000; Robin et al., 1998; Weisner et al., 1984). In the past, binge drinking among Native American Indians has been described as an intense bout of drinking in which large amounts of alcohol are drunk over a period of days that is terminated only when all readily available sources of alcohol are used up or unconsciousness occurs (Westermeyer, 1979). The import of this drinking pattern in the development of alcohol dependence in Native Americans has been the subject of some debate. Anecdotal reports of Indian binge drinkers who reportedly drank heavily for many years and who stopped drinking apparently without difficulty in middle age without serious physical, psychological or social sequelae were cited as possible evidence that Indian drinking might be substantially different in nature from that seen in other ethnic groups (May and Smith, 1988). These kinds of case reports have also been used to argue against the presence of severe “dependence” on alcohol in such individuals.

More recent studies of drinking patterns in Native American communities, however, suggest that increasing quantity and frequency of drinking is associated not only with increased numbers of alcohol dependence symptoms and rates of alcohol dependence (O'Connell et al., 2006) but also alcohol related physical and psychiatric problems in the drinking individuals themselves (May et al., 2002; O'Connell et al., 2006) and, where maternal binge drinking occurs during pregnancy, in their children (Iyasu et al., 2002; May and Gossage, 2001; Whitbeck and Crawford, 2009).

In the general U.S. population, increasing quantity and frequency of alcohol consumption is clearly associated with increased rates of alcohol use disorder (AUD) symptoms, diagnoses, and alcohol related problems (Caetano et al., 1997; Dawson and Archer, 1993; Dawson et al., 1996, 2005, 2008a,b; Grant and Harford, 1990; Hasin and Paykin, 1999; Hindmarch et al., 1991; Li et al., 2007a,b; Midanik et al., 1996; Russell et al., 2004; Saha et al., 2007). In its 2007 publication, “Helping Patients Who Drink Too Much, A Clinician's Guide” (NIAAA, 2007), the National Institute on Alcohol Abuse and Alcoholism uses the 5+/4+ (male/female) drinks per drinking day as the recommended consumption criterion for screening patients in clinical practice for risk for AUD and alcohol related problems.

Several studies (Dawson and Archer, 1993; Dawson et al., 2005, 2008a,b; Midanik et al., 1996) have shown a significant association between risk drinking, as defined by drinking five or more drinks (5+) for men and four or more (4+) drinks for women in a day, with AUD using cross-sectional data. Dawson and colleagues (2008a) prospectively examined the association of risk drinking, defined as 5+/4+ drinks in a day, with DSM-IV AUD between successive waves of the National Epidemiological Survey on Alcohol and Related Conditions (NESARC). They found continuously increasing odds of having AUD with increasing frequencies of 5+/4+ drinking.

One important approach to examining the relationship between alcohol consumption and alcohol use disorder symptoms is Item Response Theory (IRT). IRT is a technique for evaluating the relationship between observed assessment criteria or “items” and an underlying unobserved latent trait or construct. Using IRT analysis of the NESARC dataset, Saha and colleagues (2007) showed that drinking 5+/4+ (male/female) standard drinks per drinking day at a frequency of once or more per week in the past year closely demarcated the portion of the AUD severity continuum where past year AUD symptoms began to occur with a probability of 50%. Drinking 5+/4+ drinks per drinking occasion at frequencies of less than once a week (i.e., once or more per month on average over the past year and once or more in the past year) were not as closely associated with having past year AUD symptoms. Alcohol abuse and dependence symptoms were found to be intermixed along the severity continuum, suggesting that alcohol abuse and alcohol dependence are not distinct disorders. Three alcohol abuse symptoms, “Legal Problems”, “Role Neglect”, and “Social/Interpersonal Problems” were among the four most severe AUD symptoms, suggesting that alcohol abuse is not less severe than alcohol dependence. In the study of Saha and colleagues (2007), all AUD symptoms occupied the severe (defined as > 1.0 S.D. above the symptom severity mean) or very severe (defined as >2.0 S.D. above the symptom severity mean) portion of the severity continuum, suggesting that DSM-IV symptoms, as assessed in the NESARC, did not capture the moderate (defined as -1.0 to 1.0 S.D. from the symptom severity mean) or the mild (defined as <1.0 S.D. from the symptom severity mean) portions of the severity continuum.

IRT analysis has also been used to examine both past year and lifetime DSM-IV AUD symptoms in several previous studies of adults and adolescents from epidemiological, community, and treatment samples (Kahler and Strong, 2006; Kirisci et al., 2006; Krueger et al., 2004; Langenbucher et al., 2004; Lynskey and Agrawal, 2008; Martin et al., 2006; Saha et al., 2006). In general, these studies have found that alcohol abuse and dependence symptoms are intermixed in terms of severity, and that AUD symptoms occupied the moderate and severe portions of the severity continuum. AUD symptom severity and order of severity of those symptoms varied among the studies, suggesting that the nature of the sample plays an important role in determining symptom severity.

An important assumption of IRT is unidimensionality (de Ayala, 2009; Embretson and Reise, 2000). In the case of IRT analysis of AUD criteria, the unidimensionality assumption is that the AUD symptoms arise from and can be used to represent a single underlying latent AUD severity trait or continuum. Previous studies of DSM AUD symptoms have generally shown that the unidimensionality assumption is justified (Kahler and Strong, 2006). It should be noted that most studies have found evidence for some multidimensionality in adult epidemiologic (Grant et al., 2007; Kahler and Strong, 2006; Muthen et al., 1993; Proudfoot et al., 2006; Saha et al., 2006), male twin (Beseler et al., 2006), and treatment (Feingold and Rounsaville, 1995; Langenbucher et al., 2004) samples. Nevertheless, IRT analysis of AUD symptoms can be undertaken in a sample if the symptoms display sufficient unidimensionality to justify the use of IRT. Sufficient unidimensionality is considered to

exist if the one factor analytic model of symptoms exceeds certain values of several commonly used model fit indices (Brown, 2006).

This study sought to examine lifetime AUD symptom severity and its relationship to heaviest lifetime binge drinking, as defined by 5+/4+ consumption criteria, in an American Indian community sample. Assessing that relationship across the lifespan provides an answer to the question as to whether or not binge drinking, as defined by 5+/4+ criteria, is in some way a benign phenomenon in this American Indian community sample. Because the rate of past 6-month complete remission from alcohol dependence in an earlier version of this sample was 59% (Gilder et al., 2008), analyzing the data only for past year symptom severity and consumption would have excluded many informative individuals and would not have been able to the question posed by this study.

To characterize the relationship between AUD symptom severity and binge consumption criteria we used IRT analysis to examine the behavior of the AUD symptoms without a consumption criterion and with each consumption criterion along an underlying AUD latent trait continuum. Finally, we used Differential Item Functioning (DIF) analysis to determine if severity of symptoms differed in groups defined by gender and age at interview (18-24 vs. ≥ 25 years). DIF in AUD symptoms and/or consumption criteria in different groups indicate that those symptoms and criteria may measure different levels of AUD severity in the different groups. For example, a given symptom may indicate a higher level of AUD severity in females as compared to males. Young adults who are drinking are not yet through their age of risk for developing AUD symptoms (and AUDs) and hence may show differences in symptom severity compared to older individuals.

Methods

Participants

Five hundred and thirty ($N = 530$) American Indian participants were recruited from eight geographically contiguous reservations with a total population of about 3,000 individuals. Participants were recruited using a combination of a venue-based method for sampling hard-to-reach populations (Kalton and Anderson, 1986; Muhib et al., 2001) and a respondent-driven procedure (Heckathorn, 1997) which has been described elsewhere (Gilder et al., 2004). To be included in the study, participants had to be at least 1/16th Native American Heritage (NAH), be between the ages of 18 and 70 years, and be mobile enough to be transported from his or her home to the General Clinical Research Center (GCRC) of The Scripps Research Institute (TSRI). Approximately half of the participants were recruited using each method. A 10-25% rate of refusal using the venue method occurred depending on venue. The refusal rate in the respondent-driven procedure is not known. The protocol for the study was approved by the Institutional Review Board (IRB) of TSRI, the Scientific Advisory Committee of the GCRC, and the Indian Health Council, a tribal review group overseeing health issues for the reservations where recruitment was undertaken. Written informed consent was obtained from each participant after the study was fully explained.

Measures

Each participant completed an interview with the Semi-Structured Assessment for the Genetics of Alcoholism (SSAGA) (Bucholz et al., 1994), which gathers demographic, alcohol use, alcohol abuse, alcohol dependence, and psychiatric disorder symptoms. The SSAGA is a fully structured, poly-diagnostic psychiatric interview that is able to generate DSM-IV AUD symptoms and has undergone both reliability and validity testing (Bucholz et al., 1994; Hesselbrock et al., 1999). The SSAGA interviews were administered by trained

research assistants. All interviews were reviewed and all best final diagnoses were made by a research psychiatrist/addiction specialist (DAG).

Participants were included in this study if they had initiated regular drinking and reported drinking at least four drinks in one 24 hour period at least once during their lifetimes. We conditioned our sample on these parameters because the SSAGA “skips out” of the alcohol section and does not inquire about alcohol use related symptoms if participants had not experienced both in their lifetimes. Regular drinking was defined as the era in the participant's life in which he or she first engaged in drinking one or more standard drinks per drinking day for one or more days per month for six months in a row or more. Quantity and frequency of drinking over the lifetime were determined using a time line follow back approach that is a part of the SSAGA. The time line follow back instrument in the SSAGA collects drinking quantity in standard drinks per drinking day and drinking frequency in number of drinking days per month over the lifetime beginning with the initiation of regular drinking. For the purposes of this study, the era of heaviest lifetime drinking was considered to be that period in the participant's life in which the quantity $\times$ frequency ($q \times f$) yielded the highest number.

In this study, alcohol use related symptoms were used to diagnose the presence or absence of each DSM-IV AUD symptom. For the purposes of this analysis, alcohol consumption criteria during the period of heaviest lifetime drinking were generated as a series of four dichotomous variables for males and females using 5+/4+ (standard drinks per drinking day for males/standard drinks per drinking day for females) assessed separately at each of 4 frequencies: $\geq 1/\text{month}$, $\geq 4/\text{month}$, $\geq 8/\text{month}$, and $\geq 15/\text{month}$. The lowest consumption variable was drinking 5+/4+ at a frequency of $\geq 1/\text{month}$ versus drinking $<5/<4$ (standard drinks per drinking day for males/standard drinks per drinking day for females) and/or drinking at a frequency of $<1/\text{month}$ during the period of heaviest lifetime drinking. The next higher consumption variable was drinking 5+/4+ at a frequency of ≥ 4 per month versus drinking $<5/<4$ drinks and/or drinking at a frequency of $<4/\text{month}$, and so on to generate four separate dichotomous $q \times f$ variables. These $q \times f$ variables thus represented a series of increasing consumption criteria assessed during the period of heaviest lifetime drinking.

Data Analysis

Analyses were conducted on all data from participants who reported drinking at least four drinks in one 24 hour period at least once and had initiated regular drinking during their lifetimes. In our sample, the alcohol abuse symptom of “Legal Problems” was fully embedded within the alcohol abuse symptom of “Social/Interpersonal Problems.” For that reason, “Legal Problems” was excluded from further analysis, leaving 10 AUD symptoms for the subsequent factor and IRT analyses. Mplus statistical software (Múthen and Múthen, 2008, Los Angeles, CA) was used to investigate one and two factor models of the 10 AUD symptoms without a consumption criterion and the 10 AUD symptoms with each of the four consumption criteria. A tetrachoric correlation matrix of the AUD symptoms was analyzed using Mplus. Factor loadings in both the one and two factor models were represented as rotated solutions using GEOMIN rotation in Mplus. Exploratory Factor Analysis (EFA) was used to model one and two factor solutions without making predictions as to which variables would load onto which factors. The resulting one factor and two factor solutions were then used to conduct a Confirmatory Factor Analysis (CFA) to generate indices of model fit. This approach has been used in several previous IRT analyses of drug and alcohol related disorders (e.g., Argawal and Lynskey, 2007; Compton et al., 2009; Saha et al., 2006). Model fit indices included chi-squared test of model fit, determination of eigenvalues, Comparative Fit Index (CFI), Tucker Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA) and Bayesian Information Criteria (BIC). Given that CFI, TLI, and RMSEA values will improve by definition with the addition of each factor to the model in an EFA

(Krueger et al., 2004), greater weight was given to BIC values. The BIC protects against over-fitting of the data by including a penalty term for added parameters (Schwarz, 1978). CFI and TLI values $>.95$ and RMSEA values $<.06$ were interpreted as indicators of adequate model fit as suggested by Brown (2006).

IRT analyses were used to generate two-parameter logistic IRT models of the 10 AUD symptoms to characterize the behavior of each AUD symptom along an underlying latent trait severity continuum using the BILOG-MG statistical program (Scientific Software International, 2003, Lincolnwood, IL). The BILOG-MG program generated marginal maximum likelihood estimates for a discrimination (a) and a severity (b) parameter used to describe each symptom in the two-parameter model. Using the BILOG-MG software, each symptom was also graphically represented as an s-shaped logistic criterion response curve showing the likelihood of the occurrence of the symptom along the underlying severity continuum. The same EFA, CFA, and IRT analytic approach was used to examine models of the 10 AUD symptoms with each of the four consumption variables in order to assess the dimensionality of the data and to assess the relationship of each consumption variable to the AUD symptoms along the underlying latent AUD severity continuum.

The BILOG-MG program was also used to examine each AUD symptom for Differential Item Functioning (DIF) (de Ayala, 2009; Embretson and Reise, 2000) of the b parameter by comparing subgroups defined by gender and a dichotomized age at interview variable (18-24 vs. ≥ 25 years). In the context of the present analysis, DIF occurs when an AUD symptom does not have the same severity value in the two subgroups, which indicates that that symptom measures a more severe level of the AUD latent severity trait in the subgroup with the higher b value. Effect sizes for each DIF analysis were calculated by dividing the difference in mean b for each AUD symptom by its standard deviation. A t-test was used to assess whether that difference was significant at the $p < 0.05$ level.

Results

Six hundred and twenty participants (620) were assessed for lifetime alcohol use and alcohol use disorder symptoms. Five hundred and thirty participants had a history of initiating regular drinking and of drinking four or more drinks in a 24 hour period at least once during their lifetime. Complete information was available for lifetime AUD symptoms and for $q \times f$ of alcohol use during the period of heaviest lifetime use on these 530 individuals. Demographic characteristics of the sample as a whole are shown in Table 1. Demographic characteristics resemble those of U.S. Census data for these Indian tribes (United States Bureau of the Census, 1990).

The prevalence of each AUD symptom in this sample can be seen in Table 2. The most prevalent symptoms were: "Social/Interpersonal Problems" (74.5%), "Tolerance" (66.0%), "Hazardous Use" (59.2%), and "Larger/Longer" (58.3%). The least prevalent symptoms were: "Physical/Psychological Problems" (38.7%), "Time Spent" (37.4%), "Activities Given Up" (29.1%), and "Withdrawal" (21.7%) (Table 2).

The results of factor analyses of the 10 AUD symptoms are also shown in Table 2. Factor loadings from the EFAs shown in the table represent unstandardized estimates, and the fit indices displayed were generated for the one and two factor EFA solutions that were then used to conduct the CFAs. As can be seen from Table 2, the one factor and two factor models demonstrated good fit to the data. Both the Comparative Fit Index (CFI) and Tucker Lewis Index (TLI) were well above 0.95 and the Root Mean Square Error of Approximation (RMSEA) below 0.06 in both models. By definition, the two factor was superior to the one factor model in showing higher CFI and TLI indices and lower RMSEA. Of more relevance,

the Chi-Square difference test was significant suggesting that the second factor could not be dropped from the model without a significant decline in model fit ($\chi^2(9) = 22.78, p = 0.007$). Nonetheless, it is notable that the two factors were highly correlated ($r = .699$) suggesting that while there may be some evidence of multidimensionality, a single factor model might still be preferable. In support of this conclusion, the one factor was superior to the two factor model in showing a lower BIC in the one as compared to the two factor model. An examination of the results from the original EFA showed a high ratio of first to second eigenvalues (7.45) with a second eigenvalue less than 1.0 in the two factor model, which also supports the selection of the one factor solution as the best fitting. Thus, these results were interpreted as evidence supporting sufficient unidimensionality for the subsequent IRT analysis (Bentler, 1990; Brown, 2006; Cook et al., 2009; Hu and Bentler, 1999; Saha et al., 2007; Tucker and Lewis, 1973).

In the two-parameter (a and b) IRT model of the 10 AUD symptoms, symptoms ranged in severity from the least severe, “Social/Interpersonal Problems” ($b = -0.78$), “Tolerance” ($b = -0.64$), and “Hazardous Use” ($b = -0.39$), to the most severe, “Time Spent” ($b = 0.39$), “Physical/Psychological Problems” ($b = 0.40$), “Activities Given Up” ($b = 0.72$), and “Withdrawal” ($b = 1.05$). The 10 AUD symptoms occupied the moderate severity (b from -1.0 to 1.0) portion of the continuum with the exception that Withdrawal ($b = 1.05$) occupied the lower end of the severe ($b > 1.0$) portion of the continuum. None of the AUD symptoms occupied the mild ($b < -1.0$) portion of the continuum. Role Failure ($b = -0.16$), a DSM-IV symptom of alcohol abuse, was more severe than two DSM-IV symptoms of alcohol dependence, Tolerance ($b = -0.64$) and Larger/Longer ($b = -0.2$).

The results of the factor analyses of the 10 AUD symptoms when each of the four consumption criteria were separately applied showed sufficient evidence of unidimensionality in all four models to justify proceeding with IRT analysis (see Table 3). As in the case of the CFAs of the 10 AUD symptoms without a consumption criterion, CFI and TLI values were >0.95 and RMSEA values were <0.06 for the one factor models, and BIC values suggested superiority of the one compared to the two factor model. The chi-squared test of model fit was significant in each instance, again suggesting some multidimensionality in the data, but an examination of the EFA results showed high ratios of first to second eigenvalues with the eigenvalues of the second factor less than 1.0 for each consumption criteria model.

In all four one factor consumption models, the consumption criteria loaded well onto the 10 AUD symptom model with factor scores close to (0.563 for ≥ 1 days per month) or within the range (0.628 for ≥ 4 days per month to 0.646 for ≥ 15 days per month) of the factor scores of the 10 AUD symptoms without the consumption criteria. Loadings of the second factor in the two factor consumption models were, with only four exceptions, below 0.500 and were not consistent across consumption models. Those exceptions were Cut Down/Control with a factor loading of 0.861 in the second factor of the two factor 10 AUD symptom model and 0.520 in the second factor of the 5+/4+ at ≥ 8 days per month model, Hazardous Use with a factor loading of 0.554 in the second factor of the two factor 5+/4+ at ≥ 1 days per month model, and Tolerance with a factor loading of 0.746 in the second factor of the two factor 5+/4+ at ≥ 1 days per month model. The reason for this instability of the factor loading across the two factor models is unclear. One explanation might be that the instability is due to collinearity of symptoms and consumption criteria. Analysis of phi correlations of each consumption criterion with each AUD symptom did not support this explanation. No correlation was higher than 0.414 (all correlations were highly reliable with p values less than 0.01 with only one exception). Another explanation may be that the latent factors themselves are highly correlated. The high factor correlation (0.699 and 0.588,

respectively) in the 10 AUD symptom model and the 5+/4+ at ≥ 1 days per month model, where most of the factor loading instability occurs, is consistent with this explanation.

IRT analyses were applied to the four models of the 10 AUD symptoms using the four consumption criteria for both the two-parameter (a and b) model. Discrimination (a) and severity (b) parameters for the AUD symptoms and consumption criteria in the four IRT consumption models are shown in Table 3. The consumption criteria demonstrated progressive increase in severity (b , S.E.) from the lowest (-2.40, 0.27) to the highest (0.16, 0.09) consumption criterion. As can be seen in Table 3, the consumption criterion Drank 5+/4+ (M/F) at least 8 times per month ($b = -0.80$, S.E. = 0.11) demarcated the portion of the severity continuum where AUD symptoms began to occur at a probability of 50%.

Figure 1 is a graphic displays of the criterion response curves for the 10 AUD symptoms and the consumption criterion of 5+/4+ at ≥ 8 days per month (-0.80, 0.11). The figure graphically represents that that consumption criterion most closely demarcated the portion of the severity continuum where AUD symptoms began to occur at a lifetime probability of 50%.

DIF analysis showed four significant differences (effect size, t-test, p-value) in symptom severity when groups were compared on the basis of gender and age at interview. "Hazardous Use" was less severe (0.090, 2.12, 0.038) and "Activities Given Up" more severe (0.106, 2.45, 0.014) in men compared to women. "Hazardous use" was less severe (0.096, 2.20, 0.028) and "tolerance" more severe (0.087, 2.24, 0.045) in those aged ≥ 25 years compared to participants who were <25 years old at the time of the interview.

Discussion

The findings of this study indicate that an increased frequency of binge drinking is associated with a higher risk for AUD symptoms in this American Indian community sample. These findings are similar to what has been reported in a U.S. national epidemiologic sample (Saha et al., 2007), suggesting that binge drinking has similar deleterious consequences in Indian communities as it does in the general U.S. population. This result is consistent with previous work in predominantly EuroAmerican epidemiologic samples showing that higher amounts of alcohol consumption are associated with higher rates of AUD diagnoses and alcohol related problems (Dawson et al., 1996, 2005, 2008a,b; Grant and Harford, 1990; Hasin and Paykin, 1999; Hindmarch et al., 1991; Li et al., 2007a,b; Midanik et al., 1996; Russell et al., 2004; Saha et al., 2007). Binge drinking, at least at frequencies of once or more per month, is not a benign form of drinking in either this American Indian sample or in the U.S. population as a whole.

The findings of this study do not confirm the current DSM-IV dichotomy between alcohol abuse and dependence and indicate that DSM-IV alcohol abuse symptoms are not, as a group, milder than dependence symptoms in this sample. These findings are similar to the findings of several IRT analyses of DSM-III-R and DSM-IV AUD symptoms from a variety of predominantly EuroAmerican samples, including adults (Langenbucher et al., 2004) and adolescents (Martin et al., 2006) from inpatient and out-patient addiction treatment programs, community family studies (Krueger et al., 2004), and the NESARC epidemiologic sample (Kahler et al., 2006; Lynskey and Agrawal, 2008; Saha et al., 2006, 2007). Taken together, the results of this study and these other IRT studies are consistent with the notion that alcohol abuse and dependence diagnoses as currently formulated measure the same disorder in both American Indians and in EuroAmericans. Additionally, these data suggest that the symptoms of alcohol use occur on a single underlying severity continuum in both this Indian community and in the general population. Taken together, these findings call into

question the current DSM-IV diagnostic distinction between alcohol abuse and alcohol dependence and suggest that a single diagnosis, AUD, is more appropriate.

In this sample, “Activities Given Up” and “Withdrawal” were the most severe AUD symptoms. This result is consistent with the findings of Bucholz and colleagues (1996), Hasin and colleagues (2000), and Schuckit and colleagues (1998, 2003) that a withdrawal component to a DSM-IV diagnosis of alcohol dependence is associated with a more severe form of alcoholism. It is also consistent with Krueger and colleagues' (2004) extensive IRT analysis of 110 lifetime alcohol use related symptoms and behaviors in 1348 fathers who participated in the Minnesota Twin Family Study. In that sample, DSM-III-R Withdrawal symptoms ranged from feeling sad or irritable (severe portion of the underlying AUD severity continuum) to delirium tremens and seizures (very severe portion of the underlying AUD severity continuum). Martin and colleagues (2006) in an IRT analysis of DSM-IV AUD symptoms in 472 adolescents recruited from addiction treatment programs found “Withdrawal” to be the most severe AUD symptom and located on the very severe portion of the severity continuum. In contrast, Kahler and Strong's (2006) analysis of 33 past year alcohol use related symptoms and behaviors from the NESARC dataset showed “Withdrawal” symptoms ranging from “restless when effects [of alcohol] wearing off” (moderate portion of the severity continuum) to “withdrawal hallucinations and seizures” (very severe portions of the continuum). In their IRT analysis of past year DSM-IV AUD symptoms from the NESARC dataset, Saha and colleagues (2007) found that withdrawal occupied the severe portion of the AUD severity continuum, but was less severe than several other symptoms, which occupied the very severe portion of the continuum. Langenbucher and colleagues (2004), using IRT analysis to study DSM-IV AUD symptoms in 372 of adults recruited from inpatient and outpatient addiction treatment programs, found that withdrawal occupied the moderate portion of the AUD severity continuum and was less severe than both “Activities Given Up” and “Role Failure”. “Activities Given Up” was the most severe symptom in the present study and among the most severe in several IRT analyses of NESARC (Kahler and Strong, 2006; Saha et al., 2006, 2007) as well as adult (Langenbucher et al., 2004) and adolescent (Martin et al., 2006) addiction treatment samples. Taken together, these findings suggest that “Withdrawal” and “Activities Given Up” may identify a severe AUD subgroup of individuals in both predominantly EuroAmerican and American Indian populations.

Differences in AUD symptom severity between the present study and previous studies may reflect a number of differences in sampling ascertainment and instruments, assessment of past year versus lifetime AUD symptoms and severity, differences in type of sample (treatment vs. community vs. epidemiologic), and what alcohol use criteria are chosen to condition samples. For example, a sample conditioned on a lifetime history of ≥ 1 lifetime drink will contain individuals who drank less alcohol and had fewer symptoms than a sample conditioned on having drunk >3 drinks in one 24 hour period, as was the case in the present study. IRT analysis of samples containing individuals who use low amounts of alcohol and have no or few AUD symptoms will show AUD symptoms shifted to the more severe portions of the underlying severity continuum. Despite these issues, careful identification of symptoms which indicate more severity of the AUD latent trait severity continuum in samples from different ethnicities may be helpful in both screening and brief intervention in the clinical setting and in identifying subsets of individuals with varying genetic and/or environmental risk for research studies.

In this American Indian community sample, DSM-IV AUD symptoms occupied the moderate portion of the underlying latent trait severity continuum. Only withdrawal ($b = 1.05$) was above that range. This finding indicates that in this sample DSM-IV AUD symptom criteria may not adequately assess the mild and severe portions of the continuum.

However, evaluating models that also included a range of consumption criteria, demonstrated that the addition of the consumption criteria extended the assessment of the latent trait to the milder portions of the continuum. The usefulness of quantitative consumption criteria can be seen graphically by comparing Figures 1 through Figure 4. Figure 1 portrays criterion response curves for the 10 AUD symptoms and the consumption criterion of bingeing at least once per month during the period of heaviest lifetime drinking. As can be seen from Figure 1, the severity of the consumption criterion ($b = -2.40$) lies well to the left on a milder portion of the underlying AUD severity continuum than the criterion response curves for the 10 AUD symptoms. When progressively higher consumption criteria are modeled, their severities progressively increase. At bingeing at least 8 times per month during the period of heaviest lifetime drinking, the severity of the criterion response curve for that consumption criterion ($b = -0.80$) occurs at virtually the same level of severity as the least severe AUD symptom, “Social/Interpersonal Problems” ($b = -0.79$). In this sample, the highest consumption criteria, bingeing at ≥ 15 times per month during the period of heaviest during the period of heaviest lifetime drinking, occurred in the moderate portion of the continuum ($b = 0.16$). These findings indicate that these consumption criteria are useful in this sample in evaluating the milder portions of the underlying latent trait continuum and that a specific criterion (bingeing at least 8 times per month) has potential utility as both a clinical screening and diagnostic item for assessing risk for AUD symptoms in the population from which the sample was drawn. Further, the results of this study suggest that higher consumption or other criteria may be useful in assessing the severe portion of the continuum. Assessment of the mild and severe portions of the continuum is important for public education, individual intervention, and community prevention and is therefore an important goal for future IRT analyses of AUD symptoms in this and other populations. Commenting on clinical and epidemiological findings on AUD, including the findings of Saha and colleagues (2006, 2007), Li and colleagues (2007a,b) noted that alcohol consumption criteria represent an important new dimension in the conceptualization and diagnosis/screening of AUD. Li and colleagues (2007a,b) pointed to the dose response nature of alcohol use disorders, the quantitative character of consumption criteria, and their ease of use as screening and diagnostic tools. The results of this study in this American Indian community sample are consistent with and confirm the assessment of Li and colleagues (2007a,b).

DIF analysis showed significant differences in symptom severity for four symptoms in groups defined by gender and age at interview. In this sample, “Hazardous Use” was more severe and “Activities Given Up” was less severe in woman compared to men. These findings indicate that women are less likely to engage in hazardous activities and more likely to give up important activities while drinking than men and may reflect gender differences in quantity of drinking, cultural factors that affect behavior, or how risky behaviors or important activities are assessed. Kahler and Strong (2006) in their analysis of the NESARC data found that “drinking 20+ drinks”, “being arrested while drinking”, and “getting into physical fights while drinking”, but not “drinking and driving” and “reducing important activities”, were more severe symptoms in women than men. In this sample, “Hazardous Use” was less severe and “Tolerance” was more severe in those aged ≥ 25 years compared to those aged < 25 years. These age at interview findings are comparable to those of Kahler and Strong (2006) who found that “drinking and driving” was more frequently reported and “tolerance” less frequently reported by participants ≥ 25 years compared to those 18-25 years in the NESARC dataset. These findings indicate that older individuals are more likely to have engaged in hazardous activities while drinking and less likely to have experienced tolerance. Risky behavior associated with drinking probably is reported more frequently in the older age group because older individuals have had more drinking years and more opportunity to have engaged in risky behaviors while drinking. Older individuals may report less tolerance because they have experienced tolerance for more years and may

not as frequently recall the early years of drinking when tolerance developed compared to the younger age group.

While several previous factor and IRT studies of AUD symptoms have produced evidence for one factor models (Krueger et al., 2004; Lynskey and Agrawal, 2008; Martin et al., 2006; Proudfoot et al., 2006; Saha et al., 2007), other factor analytic and IRT studies have shown similar or better fit for two factor models (Beseler et al., 2006; Feingold and Rounsaville, 1995; Grant et al., 2007; Harford and Muthen, 2001; Kahler and Strong, 2006; Muthen et al., 1993) and three factor models (Grant et al., 2007) or found it necessary to remove AUD symptoms (Langenbucher et al., 2004; Saha et al., 2006) in order to achieve unidimensionality. As noted above, we found similar evidence for multidimensionality in this sample, as has been found in other IRT studies, although, not of a magnitude to preclude IRT analysis. The existence of multidimensionality suggests the presence of subgroups of AUD individuals who may have different risks, clinical courses, and/or underlying genetic and other biological factors. However, to date, findings of multidimensionality in AUD symptoms from different samples have not consistently supported any one dichotomy (including the diagnostic dichotomy of abuse and dependence). To the extent that differences in dimensionality occur, they point to the importance of further study of a range of sample types in order to determine how and when IRT findings can best be applied to clinical evaluation and research studies.

Finally, factor and IRT analyses of AUD symptom/consumption criteria are only one of several ways to examine models of the AUD syndrome, which also include test-retest studies, longitudinal studies, latent class analysis, other factor analytic approaches, mixture modeling, and discontinuity analysis. Applying a discontinuity analytic approach to the sample of lifetime drinkers from the NESARC dataset, Hasin and Beseler (2009) examined models of alcohol dependence alone and AUD with and without a 5+/4+ at least weekly consumption criterion in relation to positive family history for alcoholism and early onset of drinking. They found that their analysis was consistent with IRT findings that alcohol abuse and dependence symptoms are intermixed and lie on a single underlying severity continuum. However, when they added the consumption criterion, they found significantly poorer fit of the model to the data, raising a question about whether a weekly 5+/4+ consumption criterion should be considered for inclusion in the planned DSM-V diagnostic formulation of AUD.

Beyond the question of how well and how consistently one or more factors/consumption criteria model AUD, are public policy issues raised by reformatting the AUD diagnosis by adding a consumption measure as an additional diagnostic criterion. Keyes and colleagues (2009) examined the epidemiologic impact of including weekly 5+/4+ drinking with current AUD symptoms in four hypothetical models of AUD. The authors found that adding weekly 5+/4+ drinking increases the prevalence of AUD in the population as a whole, but that African Americans, Hispanic Americans, and women would be less likely to be diagnosed with AUD. These findings indicate that further research on the usefulness of consumption measures in AUD diagnostic formulations is warranted, particularly as it relates to ethnic and gender differences.

The results of this study should be interpreted in light of several limitations. First, our findings may not generalize to other American Indians in the population from which the sample was drawn or be representative of all American Indians. Rates of AUDs (Beals et al., 2005; Ehlers et al., 2004; Gilder et al., 2004) and patterns of alcohol consumption (Beals et al., 2003; May and Gossage, 2001; O'Connell et al., 2005, 2006) vary among tribes. IRT analyses of AUD symptom severity and consumption criteria might similarly vary among tribes. Second, we used retrospective data. Retrospective data suffers from recall bias, which

may include a reporting bias for consumption amounts and/or AUD symptoms that is affected by having developed AUD symptoms. If this bias exists, it could lead to different results for factor and IRT analyses in this study than would be found in a prospective study. A prospective study of the development of AUD symptoms and consumption amounts would provide a more powerful model for factor and IRT analyses of AUD symptoms and consumption criteria. Third, comparisons to other samples may be limited by differences in sampling techniques, conditioning of the sample, and how lifetime consumption is assessed. For example, we included in our sample only individuals who had initiated regular drinking and who had drunk more than three drinks on one or more occasions in their lives. If we had included individuals who had drunk one or more drinks in their lifetimes but not necessarily ever initiated regular drinking or drunk more than three drinks on any one drinking day, we would have included a more mildly symptomatic group in our analysis, resulting in possible shifts in the factor structure and/or in the criterion response curves to the right along the underlying AUD severity continuum. Fourth, use of consumption criteria other than those used in this study, such as lower or higher cut-off amounts or maximum drinks per 24 hours, or use of more precise measurements of drink sizes and alcohol concentrations (Greenfield and Kerr, 2008; Greenfield et al., 2006) might yield results different from those found in this study. Finally, statistically significant DIF of AUD symptoms found in this study may not be clinically meaningful because all showed small effect sizes (de Ayala, 2009, p. 326). How effect size in DIF analyses of AUD symptoms in different genders, age groups, cohorts, and ethnicities remains an important area for future study.

With these caveats in mind, we believe that this study of AUD symptom and consumption criteria in a Native American community sample adds important additional evidence in favor of AUD and 5+/-4+ consumption criteria as representing a unitary dimension and delineating the potentially important diagnostic and phenotypic advantages of assessing consumption as part of the AUD syndrome in this important high risk ethnic group. These findings emphasize that frequent binge drinking is not a benign event in this American Indian community and that it is significantly associated with alcohol use disorders. Better understanding of factors associated with these high lifetime rates of AUDs are important as possible points of intervention and prevention in this and other high risk populations.

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Figure 1.

Criterion response curves for 10 lifetime AUD symptoms and the 5+/4+ drinking at least eight days per month criterion. The probability of endorsement of each AUD symptom and the consumption criterion (Y-axis) is plotted as a function of increasing severity of the underlying AUD latent trait severity (X-axis). Each AUD symptom is labeled with its name, whether it is an alcohol abuse (AA) or alcohol dependence (AD) symptom, and its discrimination (a) and severity (b) parameters. The consumption criterion is labeled with its name and discrimination (a) and severity (b) parameters

Table 1
Demographic characteristics of 530 American Indian participants (n = 530)

<u>Variable</u>	<u>Mean</u>	<u>S.D.</u>
Age (range = 18-70)	30.8	11.8
Years of education (range = 3-16)	11.6	1.5
	<u>n</u>	<u>%</u>
Gender (n = 530)		
Male	226	42.6
Female	304	57.4
Annual income (n = 512)		
< \$20,000	248	48.4
≥ \$20,000	264	51.6
Employment (n = 509)		
Not employed	287	56.4
Part-time	149	29.3
Full-time	73	14.3
Marital status (n = 529)		
Married	94	17.8
Widowed	7	1.3
Separated	36	6.8
Divorced	46	8.7
Never married	346	65.4
Native American heritage (n = 530)		
< 50%	315	59.4
≥ 50%	215	40.6
Family history of alcohol dependence (n = 525)		
No	163	31.0
Yes	362	69.0
Age at interview (n = 530)		
< 25 years	211	39.8
≥ 25 years	319	60.2

Table 2
Prevalence and factor loadings in one and two factor models of ten lifetime DSM-IV AUD symptoms (n=530)

Lifetime DSM-IV AUD symptoms and model indices	(n=530)	Factor Model (n=530)		
	Prevalence	One Factor	Two Factors	
	(%)			
Social/Interpersonal Problems	74.5	0.870	0.670	0.254
Tolerance	66.0	0.642	0.763	-0.126
Hazardous Use	59.2	0.588	0.743	-0.166
Larger/Longer	58.3	0.747	0.429	0.392
Role Failure	55.7	0.871	0.788	0.117
Cut Down/Control	54.2	0.698	0.005	0.861
Physical/Psychological Problems	38.7	0.738	0.482	0.319
Time Spent	37.4	0.866	0.889	-0.003
Activities given up	29.1	0.782	0.531	0.315
Withdrawal	21.7	0.746	0.607	0.181
FACTOR CORRELATION			0.699	
Chi Squared Test of Model Fit		54.736	31.956	
Degrees of Freedom		35	26	
P-Value		0.018	0.195	
Eigenvalue		6.129	6.129	0.823
Comparative Fit Index (CFI)		0.996	0.999	
Tucker Lewis Index (TLI)		0.995	0.998	
Root Mean Square Error of Approximation		0.033	0.021	
Factor Score Determinancies		0.971	0.965	0.915
Bayesian Information Criteria		5583.372	5614.927	

Table 3
Prevalence and item response parameters of models of ten lifetime DSM-IV AUD symptoms and four lifetime heaviest 5+/4+ consumption criteria (n=530)

Lifetime DSM-IV AUD symptoms, heaviest consumption criteria, and model indices	Prevalence %	Models with four lifetime heaviest consumption criteria: Drank 5+/4+ (M/F) at least:							
		Once per month (two parameter model)		Four times per month (two parameter model)		Eight times per month (two parameter model)		Fifteen times per month (two parameter model)	
		Discrimination (a) estimate, a (S.E.)	Severity (b) estimate, b (S.E.)	Discrimination (a) estimate, a (S.E.)	Severity (b) estimate, b (S.E.)	Discrimination (a) estimate, a (S.E.)	Severity (b) estimate, b (S.E.)	Discrimination (a) estimate, a (S.E.)	Severity (b) estimate, b (S.E.)
Drank 5+/4+ (M/F) at least once per month	93.4	0.85(0.13)	-2.40(0.27)						
Drank 5+/4+ (M/F) at least four times per month	84.5			0.87(0.11)	-1.57(0.16)				
Social/Interpersonal Problems	74.5	1.72(0.27)	-0.77(0.08)	1.67(0.25)	-0.78(0.08)	1.61(0.24)	-0.79(0.08)	1.64(0.24)	-0.79(0.08)
Drank 5+/4+ (M/F) at least eight times per month	69.6					0.83(0.10)	-0.80(0.11)		
Tolerance	66.0	0.85(0.10)	-0.64(0.10)	0.85(0.10)	-0.64(0.10)	0.83(0.10)	-0.64(0.10)	0.85(0.10)	-0.64(0.10)
Hazardous Use	59.2	0.73(0.09)	-0.39(0.10)	0.74(0.09)	-0.39(0.10)	0.74(0.09)	-0.39(0.10)	0.74(0.09)	-0.39(0.10)
Larger/Longer	58.3	1.10(0.12)	-0.28(0.08)	1.10(0.12)	-0.28(0.08)	1.10(0.12)	-0.28(0.08)	1.04(0.12)	-0.29(0.08)
Role Failure	55.7	1.78(0.24)	-0.16(0.06)	1.77(0.24)	-0.16(0.06)	1.78(0.24)	-0.16(0.06)	1.77(0.24)	-0.16(0.06)
Cut Down/Control	54.2	0.94(0.11)	-0.15(0.08)	0.95(0.11)	-0.15(0.08)	0.95(0.11)	-0.15(0.08)	0.90(0.10)	-0.15(0.08)
Drank 5+/4+ (M/F) at least: fifteen times per month	46.0							0.82(0.09)	0.16(0.09)
Physical/Psychological Problems	38.7	1.08(0.13)	0.40(0.08)	1.08(0.13)	0.40(0.08)	1.09(0.13)	0.40(0.08)	1.10(0.13)	0.40(0.08)
Time Spent	37.4	1.67(0.22)	0.39(0.07)	1.68(0.22)	0.39(0.07)	1.66(0.21)	0.39(0.07)	1.74(0.23)	0.39(0.07)
Activities given up	29.1	1.25(0.16)	0.72(0.08)	1.23(0.15)	0.72(0.08)	1.26(0.16)	0.72(0.08)	1.24(0.16)	0.73(0.08)
Withdrawal	21.7	1.17(0.16)	1.05(0.10)	1.17(0.16)	1.05(0.10)	1.16(0.16)	1.05(0.10)	1.17(0.16)	1.05(0.10)
Bayesian Information Criteria		5805.090		5961.652		6121.191		6189.663	